Japanese Publication for Unexamined Patent Application No. 15175/1976 (*Tokukaishou* 51-15175)

The following is a full English translation of the above-identified publication.

1. TITLE

METHOD AND APPARATUS FOR MANUFACTURING ELECTRIC WIRE INSULATED BY ELECTRODEPOSITED WATER-DISPERSIBLE SYNTHETIC RESIN

2. CLAIMS

1. A method for manufacturing an electric wire insulated by an electrodeposited water-dispersible synthetic resin, comprising the steps of:

forming a film of a coating material by an electrophoretic method on a surface of an electrically conductive metal member, which coating material is made of the water-dispersible synthetic resin; and

heating in a narrow tube the electrically conductive metal member on the surface of which the film is formed, so as to evaporate, in the narrow tube, moisture contained in the coating material made of the water-dispersible synthetic resin.

2. An apparatus for manufacturing an electric wire insulated by an electrodeposited water-dispersible synthetic resin, comprising:

a narrow tube capable of continuously passing therethrough a long, electrically conductive metal member on a surface of which a film of a coating material made of a water-dispersible synthetic resin is formed by an electrophoretic method; and

heating means for heating the electrically conductive

metal member in the narrow tube so as to evaporate, in the narrow tube, moisture contained in the coating material made of the water-dispersible synthetic resin.

3. Detailed Description of the Invention

The present invention relates to a method and an apparatus for manufacturing an electric wire insulated by an electrodeposited water-dispersible synthetic resin.

The electrodeposit coating method is generally categorized into (i) a method using a water-soluble synthetic resin coating material and (ii) a method using a water-dispersible synthetic resin coating material. The method using a water-soluble synthetic resin coating material is suitable for forming a thin film having a thickness of approximately 10μ to 20μ. On the other hand, with use of a water-dispersible synthetic resin coating material, a film having a much greater thickness can be formed, and therefore the method using a water-dispersible synthetic resin coating material is drawing attention as a coating method for electric insulation.

However, in the case of electrodepositing a water-dispersible synthetic resin coating material on an electrically conductive metal member, the surface of the film is cracked when dried and hardened without applying anything. Thus, it is impossible to obtain a continuous film having a smooth surface. Consequently, in the case of coating for electric insulation by electrodepositing a water-dispersible synthetic resin coating material on an electrically conductive metal member, it was necessary to use an organic solvent as a film forming auxiliary agent. As a result, a numerous advantages regarding electrodeposit coating were lost, and environmental pollution and poor economic efficiency were caused.

The film forming characteristic of a water-dispersible

synthetic resin coating material is dominated by the dehydration rate with regard to atmospheric temperature. Specifically, in the case where the atmospheric temperature is low, the film forming characteristic is low. Further, the leveling of the film is poor. Therefore, low atmospheric temperature is not suitable for manufacturing an insulated electric wire. In contrast, although high atmospheric temperature promotes cohesion and fusion bond of water-dispersible synthetic resin particles, the dehydration rate of the film becomes very high when the temperature is overly high. This can cause foam or a cracked surface, and therefore, it is difficult to form a continuous film. As a result, in order to form a continuous film at high temperature without use of an organic solvent, the dehydration rate needs to be controlled. However, in the case of manufacturing a long electric wire insulated by an electrodeposited water-dispersible synthetic resin, it was highly difficult to set manufacturing conditions, and therefore it was difficult to put such manufacture into industrial practice.

According to the present invention, the above fundamental disadvantages such as the use of an organic solvent can be cleared, and a method and an apparatus for realizing a high linear speed of coating and thereby manufacturing an insulator-coated electric wire having a good characteristic can be provided.

As a result of various researches, the inventors of the present invention have succeeded in developing a new method and apparatus described below for manufacturing an electric wire insulated by an electrodeposit. Specifically, a water-dispersible synthetic resin coating material is electrodeposited on an electrically conductive metal member. Subsequently, the coating material is dry-baked, for example, in a narrow tube contained in a heating furnace. Consequently,

moisture contained in the electrodeposited water-dispersible synthetic resin coating material is evaporated. Since the narrow tube of the heating furnace is filled with the moisture vapor, the evaporation rate is self-adjusted. As a result, it is possible to obtain without use of an organic solvent an electric wire insulated by an electrodeposited water-dispersible synthetic resin which wire has a preferable surface.

According to the present invention, it is possible to adjust the evaporation rate of moisture included in an electrodeposit precipitate layer by use of the diameter of the tube, the length thereof or the temperature of the heating furnace. Further, conditions can be set properly with respect to the line size of the electrically conductive metal member. It is therefore highly easy to produce an apparatus for realizing the foregoing as an apparatus. The material for the narrow tube is not particularly limited, and glass, porcelain or metal is generally used.

The following explains an embodiment of the present invention with reference to the attached drawings.

Fig. 1 illustrates an apparatus used in the present embodiment. According to Fig. 1, (1) shows a long, electrically conductive metal member, (2) shows an annealing furnace, (3) shows a pretreatment tank, (4) shows an electrodeposit tank, (5) shows a heating furnace through which a narrow tube of glass or metal is inserted, and (6) shows a final baking furnace.

In an apparatus having the above arrangement, a long, electrically conductive metal member (1) for which insulation is to be provided is first inserted in the annealing furnace (2) to be annealed, so that the processing characteristic is improved. Subsequently, the electrically conductive metal member (1) is inserted in the pretreatment tank (3) so that the surface of the electrically conductive metal member (1) is subject to a cleaning process. Afterwards, in the electrodeposit tank (4), a

water-dispersible synthetic resin coating material is electrodeposited on the surface of the electrically conductive metal member (1). Immediately after the forgoing step, the long electrically conductive metal member (1) is inserted through the heating furnace (5) containing a narrow tube so that a continuous film having a lustrous surface is formed. Next, the electrically conductive metal member (1) is inserted through the final baking furnace (6) so that the above film is baked and hardened. As a result, an electric wire insulated by the electrodeposited water-dispersible synthetic resin can be obtained.

The heating furnace (5) through which a narrow tube is inserted will be explained in more detail with reference to Fig. 2.

In Fig. 2, (a) is a perspective view, and (b) is a cross sectional view. Further, (1) shows the long, electrically conductive metal member electrodeposited with a water-dispersible synthetic resin coating material, (5) shows the heating furnace through which a narrow tube is inserted, and (51) shows a narrow tube made of glass, metal or the like. It is preferable to insert the electrically conductive metal member (1) through the narrow tube (51) one by one. Alternatively, by adjusting the diameter of the narrow tube (51), it is possible to insert a plurality of the electrically conductive metal members (1) at a time and obtain a continuous film having a preferable surface and no crack or foam. The diameter of the narrow tube (51) varies depending on the line size of the electrically conductive metal member (1) which runs through the narrow tube (51), and is normally around 8 (mmϕ) to 20(mmϕ).

The following explains the method of the present invention in further detail with use of comparative examples for reference and embodiments.

[Comparative Example 1]

A water-dispersible synthetic resin coating material formed from 45% of styrene, 45% of ethyl acrylate, 5% of glycidyl methacrylate and 5% of methacrylic acid was contained in an electrodeposit tank having a length of 30 (cm). A naked copper wire having 0.5Φ was provided with a direct-current voltage of 2 (V) and passed through the water-dispersible synthetic resin coating material at a linear speed of 10 (m/min). Immediately after the foregoing step, the water-dispersible synthetic resin coating material was baked. The electric wire thus obtained had a surface having a significant crack and the appearance of the electric wire was defective.

[Comparative Example 2]

While using the water-dispersible synthetic resin coating material and the apparatus of Comparative Example 1, a naked copper wire was provided with a direct-current voltage of 2 (V) and passed through the water-dispersible synthetic resin coating material at a linear speed of 10 (m/min). Subsequently, the copper wire was immersed in N,N-dimethylformamide (DMF), an film forming auxiliary agent, for one second, and then baked. As a result, a preferable insulated electric wire whose finished film had a thickness of approximately 25μ was obtained. However, environmental pollution caused by the use of the organic solvent and loss caused by taking out were significant.

[Comparative Example 3]

While using the water-dispersible synthetic resin coating material and the apparatus of Comparative Example 1, a naked copper wire was provided with a direct-current voltage of 2 (V) and passed through the water-dispersible synthetic resin coating material at a linear speed of 10 (m/min). Subsequently, the copper wire was passed through a tube (the diameter and the length thereof being 40 (mm) and 2 (m) respectively) joined with a heating furnace whose temperature is maintained at 300

°C, and then finally baked. As a result, a defective electric wire having significant foam was obtained.

[Embodiment 1]

While using the water-dispersible synthetic resin coating material and the apparatus of Comparative Example 1, a naked copper wire was provided with a direct-current voltage of 2 (V) and passed through the water-dispersible synthetic resin coating material at a linear speed of 10 (m/min). Subsequently, the copper wire was passed through a narrow tube (the diameter and the length thereof being 8 (mm) and 2 (m) respectively) contained in a heating furnace whose temperature is maintained at 300 °C, and then finally baked. As a result, a preferable insulated electric wire whose finished film had a thickness of approximately 26μ was obtained.

[Embodiment 2]

While using the water-dispersible synthetic resin coating material and the apparatus of Comparative Example 1, two naked copper wires were provided with a direct-current voltage of 2 (V) and passed through the water-dispersible synthetic resin coating material at a linear speed of 10 (m/min). Subsequently, the resultant two copper wires were simultaneously passed through a narrow tube (the diameter and the length thereof being 12 (mm) and 2 (m) respectively) contained in a heating furnace whose temperature is maintained at 300 °C, and then finally baked. As a result, two preferable insulated electric wires whose finished film had a thickness of approximately 25μ were obtained.

The following table shows the characteristic of the electric wires produced in Comparative Examples 1, 2 and 3 and Embodiments 1 and 2.

item	Comparative Example 1	Comparative Example 2	Comparative Example 3	Embodiment 1	Embodiment 2
Wire diameter (mm)	0.5Φ	0.5Φ	0.5Φ	0.5Φ	0.5Φ
Film thickness (μ)	20 to 26	22 to 27	23 to 27	23 to 28	22 to 26
Appearance	Significant crack	Smooth, lustrous	Significant foam	Smooth, lustrous	Smooth, lustrous
Pintube (number/5m)	Many	0	Many	0	0
Voltage resistance (bent to be double stringed)(kV)	0	7.8	0	8.4	8.1
Kink	Poor	Good	Poor	Good	Good

Although a narrow tube was used in the above Embodiments, it is evident that the narrow tube can be substituted by anything that forms a narrow tube through which a metal member can be inserted.

4. Brief Description of the Drawings

Fig. 1 is a schematic view showing a manufacturing process of an electric wire insulated by an electrodeposited water-dispersible synthetic resin in accordance with the present invention. Fig. 2 (a) is a perspective view of a heating furnace through which a narrow tube is inserted, and Fig. 2 (b) is a cross sectional view of the heating furnace. In the Figures, (1) shows a electrically conductive metal member, (2) shows an

anncaling furnace, (3) shows a pretreatment tank, (4) shows an electrodeposit tank, (5) shows a heating furnacc, (51) shows a narrow tube and (6) shows a final baking furnace.

In the Figures, the same referential number refers to the same section.

公開特許公報

(11)特開昭 51-15175
(43)公開日 昭51.(1976) 2. 6
(21)特願昭 49-86443
(22)出願日 昭49.(1974) 7.26
審査請求 未請求 (全4頁)
庁内整理番号
6007 52
7004 37
7006 37
(52)日本分類
6a B633
24)D01
24)B35
(51)Int.Cl²
H01B 13/06
C25D 13/16

特許願(特許法第38条ただし書の規定による特許出願)7
昭49年7月26日

特許庁長官殿

1.発明の名称 水分散形合成樹脂電着絶縁電線の製造方法及びその装置
2.特許請求の範囲に記載された発明の数 2
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6.添付書類の目録
(1) 明細書 1通
(2) 図面 1通
(3) 委任状 1通
(4) 願書副本 1通

許可
49.7.26

明細書

1. 発明の名称

水分散形合成樹脂電着絶縁電線の製造方法及びその装置。

2. 特許請求の範囲

(1) 導電性金属材の表面に電気放電法により水分散形合成樹脂塗料の皮膜を形成する工程、上記皮膜が形成された導電性金属材を細孔内において加熱し上記水分散形合成樹脂塗料中に存在する水分を上記細孔内で蒸発させる工程を含んでなる水分散形合成樹脂電着絶縁電線の製造方法。

(2) 表面に電気放電法により水分散形合成樹脂塗料の皮膜が形成されてなる長尺の導電性金属材を内部に連続的に通過させ得る細孔と、この細孔内の導電性金属材を加熱して上記水分散形合成樹脂塗料中に含まれる水分を上記細孔内で蒸発させ得る加熱手段とを備えてなる水分散形合成樹脂電着絶縁電線の製造装置。

3. 発明の詳細な説明

本発明は水分散形合成樹脂電着絶縁電線の製造方法とその装置に関するものである。

一般に電着塗装性は、水溶性合成樹脂塗料を用いる場合と水分散形合成樹脂塗料を用いる場合に分けられるが、水溶性合成樹脂塗料を用いる場合は10~20%程度の低い皮膜を得るのに対しているが、水分散形合成樹脂塗料ではそれ以上のかたさの皮膜を得ることができるので電気絶縁塗装法として注目をあびている。

しかしながら水分散形合成樹脂塗料を導電性金属材に電着した場合にはそのままの状態で絶縁化すると著しい欠陥現象が生じ、均一な連続皮膜を得ることができない。そのため水分散形合成樹脂塗料を電着して導電性金属材に絶縁被覆をおこなう場合には皮膜形成助剤として有機溶剤を使用する必要があった。その結果電着機器における諸々の弊害が生じたり、有機溶剤による環境汚染や経済性の低下につながっていた。

水分散形合成樹脂塗料の皮膜形成性は界面反

温度乾燥速度に支配される。即ち、雰囲気温度が低い場合には皮膜の形成性が悪く、かつ皮膜のレベリングが悪いため絶縁電線の製造には不適当である。これに対して、雰囲気温度が高いほど水分散形合成樹脂粒子相互の融着、融着は促進されるが、温度が高すぎると皮膜の乾燥速度が非常に速くなり、発泡あるいは表面亀裂の原因となり連続皮膜を得るのが困難である。そのため有機溶剤を用いずに高温度で連続皮膜を形成させるには乾燥速度を制御する必要があるが、長尺の水分散形合成樹脂電着電線を製造する場合には製造上、条件設定が非常に難かしく工業化が困難であつた。

本発明は上記した有機溶剤を用いるという根本的欠点を解決し、高速度で製造でき、優れた特性を有する絶縁被覆電線の製造方法とその装置を提供するものである。

本発明者らは種々研究を重ねた結果、下記のごとき新規な電着絶縁電線の製造方法及び装置を開発した。即ち水分散形合成樹脂塗料を導電性金属材上に電着し、しかる後に加熱炉に組込まれた例えば細管中で乾燥焼付を行なう。これにより電着された水分散形合成樹脂塗料中に存在する水が蒸発し、加熱炉の細管中に充満するため蒸発速度が自己調節されるものであり、有機溶剤を用いずに表面良好な水分散形合成樹脂電着電線を得ることができるものである。

又、本発明によれば電着被出線内の水分の蒸発速度は、細孔を形成する例えば細管の管径、管長あるいは加熱炉の温度によつても調節でき、導電性金属材の線サイズによつて適宜に条件が設定され得るし、機械化が非常に簡単であることも特徴としている。細管の材質は耐熱材であれば、特に限定しないが、一般にガラス、陶器、金属などが用いられる。

次に本発明の一実施例を図面に基づいて説明する。

第1図は本発明の実施に用いる装置を示し、図中、(1)は長尺の導電性金属材、(2)は焼鈍炉、(3)は脱脂洗浄槽、(4)は電着槽、(5)はガラス材または金属材の細管を挿入した加熱炉、(6)は最終焼付炉である。

上記のような構成の装置において、絶縁を施すべき長尺の導電性金属材(1)を先ず焼鈍炉(2)に入れ焼鈍して加工性を高める。ついでこれを脱脂洗浄槽(3)を通すことにより表面を清浄に処理し、更に電着槽(4)でその表面に水分散形合成樹脂塗料を電着し、その後ただちに細管を組込まれた加熱炉(5)を通過させることにより表面光沢のある連続皮膜を形成させる。次いで、最終焼付炉(6)で、上記皮膜の焼付硬化がおこなわれることにより水分散形合成樹脂電着電線が得られるものである。

次に第2図により上記細管を挿入した加熱炉(5)に関し、更に詳細に説明する。

即ち、第2図に於て、(a)は斜視図、(b)はその断面図を示しており、(1)は水分散形合成樹脂塗料を電着した長尺の導電性金属材、(5)は細管を挿入した加熱炉、(7)はガラスあるいは金属材等でできた細管である。このとき細管(7)を通す導電性金属材(1)は一本ずつの方が好ましいが複数本でも可能であり細管(7)の管径を調節することによつて表面亀裂あるいは発泡のない表面良好な連続皮膜を得ることができる。細管(7)の管内径は走行する導電性金属材(1)の線サイズによつても異なるが、通常2(mmφ)〜20(mmφ)程度のものが使用される。

以下本発明の方法を実施例としての比較例と、実施例により更に詳細に説明する。

〔比較例1〕

スチレン46部、アクリル酸ブチル46部、グリシジルメタクリレート5部、メタクリル酸3部の組成からなる水分散形合成樹脂塗料を長さ80(cm)の電着槽に入れ、0.4φの銅線を直流電圧2(V)を印加して線速10(m/min)で走らせ、ただちに焼付けると表面亀裂が著しい外観不良の電線を得た。

〔比較例2〕

比較例1の水分散形合成樹脂塗料と銅線を用い、直流電圧2(V)を印加し、線速10(m/min)で

走らせ、つづいて成膜形成前剤である N,N-ジメチルホルムアミド(DMF)に1秒間浸漬させた後乾燥付けると、仕上り皮膜 25〔μ〕程度の良好な絶縁電線を得た。有機溶剤の使用による環境汚染、及び作出しによる損失が著しい。

〔比較例3〕

比較例1の水分散形合成樹脂塗料と銅線を用い、直流電圧 3〔V〕を印加し、線速 10〔m/min〕で走らせ、つづいて 300℃に保たれた加熱炉に吊り下げられた管中(管径 40〔mm〕長さ 2〔m〕)を通過させた後巻線機付することにより外観の著しい不良電線を得た。

〔実施例1〕

比較例1の水分散形合成樹脂塗料と銅線を用い、直流電圧 3〔V〕を印加し、線速 10〔m/min〕で走らせ、つづいて、300℃〔C〕に保たれた加熱炉中の縦管(管径 3〔mm〕長さ 2〔m〕)を通過させた後巻線機付することにより仕上り皮膜 20〔μ〕程度の良好な絶縁電線を得た。

〔実施例2〕

比較例1の水分散形合成樹脂塗料と銅線を用い直流電圧 3〔V〕を印加し、線速 10〔m/min〕で走らせた。こうして得られた電線線径 3 本を同時に 350℃〔C〕に保たれた加熱炉中の縦管(管径 12〔mm〕長さ 2〔m〕)を通過させた後巻線機付することにより仕上り皮膜 25〔μ〕程度の良好な絶縁電線を 3 本得た。

次に、比較例1、2、3および実施例1、2で製造した電線の特性を次の表に示す。

項目	比較例1	比較例2	比較例3	実施例1	実施例2
線径(mm)	0.8φ	0.8φ	0.8φ	0.8φ	0.8φ
皮膜厚(μ)	20~26	23~27	23~27	23~28	23~26
外観	著しい電蝕	平滑光沢あり	著しい斑点	平滑光沢あり	平滑光沢あり
ピンホール(ケ/5m)	多数	〃	多数	0	0
破壊電圧(交流)(kV)	0.1	2.8	0	5.4	5.1
ヤンク	悪	良	悪	良	良

尚、以上の実施例で成膜管を用いた場合につ

いて述べたが、金属材を挿入し得る細孔を形成するものであれば管でなくとも良い事は勿論である。

4. 図面の簡単な説明

第1図は本発明による水分散形合成樹脂塗料絶縁電線の製造工程を示す概略図、第2図(a)は成膜管を挿入した加熱炉の斜視図、第2図(b)はその断面図である。

図中、(1)は導電性金属材、(2)は成膜炉、(3)は成膜線、(4)は巻取機、(5)は加熱炉、(6)は成膜管、(6')は金属挿入材料である。

尚、図中同一符号は同一部分を示す。

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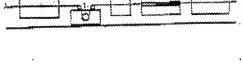
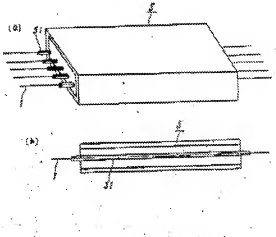
第1図



第2図



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手続補正書(自発)

昭和50年1月18日

特許庁長官殿

1. 事件の表示 特願昭 48-88648

2. 発明の名称
水分散形合成樹脂電着塗装の製造方法及びその装置

3. 補正をする者
事件との関係 特許出願人
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5. 補正の対象 明細書の発明の詳細な説明の欄
6. 補正の内容
(1) 明細書をつぎのとおり訂正する。

ページ	行	訂正前	訂正後
3	5	かさばり	かさ厚い
3	14	いつ様	いつた様
6	5	挿出器	折出器
9	12	電着塗装	電着絶縁塗装

以上